REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have incorporated the subject matter of each of claims 6 and 11 into claim 1; and, moreover, have further amended claim 1 to recite that the binder polymer contains 3-30% by weight, relative to all copolymerizable components, of styrene or a styrene derivative as a copolymerizable component. Note, for example, paragraph [0038] bridging pages 11 and 12 of Applicants' specification. In light of amendments to claim 1, claims 6, 11 and 20 have been cancelled without prejudice or disclaimer, and dependency of claim 7 has been amended. Furthermore, claim 5 has been amended to recite that the (C) photopolymerization initiator "also" contains the recited dimer.

In addition, Applicants are adding new claims 21 and 22 to the application. Claims 21 and 22, dependent respectively on claims 16 and 1, respectively recites that the light radiated upon the photosensitive resin layer during the exposing step has a wavelength in a range of 400-450 nm; and recites that the styrene or styrene derivative included in the binder polymer is styrene. In connection with claim 21, note, for example, paragraph [0083] bridging pages 27-29 of Applicants' specification.

The objection to claim 6 as set forth in Item 4 on page 3 of the Office Action mailed December 11, 2008, is noted. Claim 1, incorporating the subject matter of previously considered claim 6, recites that the photosensitive resin composition "also contains" the acylphosphine oxide compound as previously set forth in claim 6. See also amendments to claim 5. In view of claim 1 as presently amended, it is respectfully submitted that the objection to previously considered claim 6 is moot.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed December 11, 2008, that is, the teachings of U.S. Patent No. 7,148,382 to Wolf, et al., and Japanese Patent Document No. 2001-201851 to Sakanashi, et al., under the provisions of 35 USC 102 and 35 USC 103.

Initially, it is noted that while the Examiner has applied U.S. Patent No. 7,148,382 to Wolf, et al., this patent has not been set forth on the Form PTO-892 enclosed with the Office Action mailed December 11, 2008. That is, while the Examiner has listed U.S. Patent Application Publication No. 2004/0204613 to Wolf, et al., Patent No. 7,148,382 has not been listed. While No. 2004/0204613 corresponds to U.S. Patent No. 7,148,382, for completeness and clarification of the record it is respectfully requested that the Examiner list U.S. Patent No. 7,148,382 on a Form PTO-892.

Furthermore, it is noted that Applicants have incorporated the subject matter of claim 6 into claim 1; and, moreover, claim 6 was not rejected under 35 USC 102 as anticipated by the teachings of Sakanashi, et al., in Item 1 on page 2 of the Office Action mailed December 11, 2008. Accordingly, it is respectfully submitted that the anticipation rejection as set forth in Item 1 on page 2 of the Office Action mailed December 11, 2008, is moot.

In any event, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a photosensitive element as in the present claims, including, inter alia, wherein the photosensitive resin composition layer provided on a support is composed of a

photosensitive resin composition containing, inter alia, (A) a binder polymer which contains 3-30% by weight, relative to all copolymerizable components, of styrene or a styrene derivative as a copolymerizable component, the photosensitive resin composition also containing, as (C) a photopolymerization initiator, both (1) a thioxanthone-based compound represented by the chemical formula (I) and an acylphosphine oxide compound represented by the formula (II) in claim 1.

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a photosensitive element as in the present claims, including components of the photosensitive resin composition layer as discussed in the foregoing in connection with claim 1, and wherein the photosensitive element has the property of photosensitivity to light at a wavelength in a range of 400-415 nm. Note claim 1.

In addition, it is respectfully submitted that the teachings of the applied references would have neither taught nor would have suggested such photosensitive element as in the present claims, having features as discussed in the foregoing in connection with claim 1, and, additionally, wherein the weight average molecular weight of the (A) binder polymer is 5,000-300,000 (see claim 2); and/or wherein the (B) photopolymerizable compound, included in the photosensitive resin composition layer, has a bisphenol A-type (meth) acrylate compound as an essential component thereof (see claim 3); and/or wherein the (B) photopolymerizable compound has a compound having one ethylenic unsaturated bond in a molecule and also a compound having two or more ethylenic unsaturated bonds in a molecule (see claim 4); and/or wherein the (C) photopolymerization initiator also contains a 2,4,5-triarylimidizole dimer (see claim 5);

and/or wherein the acylphosphine oxide compound is a compound represented by the formula (III) in claim 7; and/or wherein the element is exposed to light in which the area integrated intensity a at a wavelength of 400-450 nm in the oscillation spectrum of a light source is ten times or more the area integrated intensity b at a wavelength of 300 nm to less than 400 nm (see claim 10); and/or wherein the element is exposed to light at a wavelength of 400-415 nm (see claim 11), or is exposed to light emitted from a gallium nitride-based semiconductor laser (see claim 12), or a blue laser (see claim 13); and/or wherein the photosensitive element is exposed to light in which at least 90% of light having a wavelength of 365 nm or less emitted by the light source is cut off (see claim 14); and/or wherein such element is exposed by a direct writing method in which exposure light is in the form of an image by arranging a plurality of mirrors and changing the angle of each mirror as necessary (see claim 15); and/or wherein styrene is included in the (A) binder polymer (see claim 22).

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a resist pattern formation method or such printed wiring board production method as in the present claims, utilizing the photosensitive element according to claim 1 (see claims 16 and 17), in particular, wherein the exposing step of formation of the resist pattern utilizes light having a wavelength in a range of 400-450 nm (see claim 21).

The present invention is directed to a photosensitive element, a resist pattern formation method and a printed wiring board production method.

Photosensitive elements obtained using a photosensitive resin composition layer along with a support have been widely used as resist materials in an etching treatment

or plating treatment in the production of printed wiring boards. Mercury lamps have mainly been used for the light source for pattern exposure; however, since light from a mercury lamp contains ultraviolet rays (light having a wavelength of, e.g., less than 400 nm or less) that are harmful to the human body, it has problems in terms of work safety. While there are also exposure methods that use a visible light laser for the light source, these methods require the use of a resist sensitive to visible light, and these resists have limitations on the environment in which exposure can be carried out, e.g., exposure has to be carried out in a dark room or under a red lamp.

In view of the foregoing, light from which 99.0% or more of the light having a wavelength of 365 nm or less from a light source, such as that from a mercury lamp light source, is cut off, has come to be used for pattern exposure; or, alternatively, gallium nitride-based blue laser light sources, which generate light having a wavelength of 400-450 nm, have come to be used for pattern exposure.

However, photosensitive elements of the prior art have been designed to accommodate all wavelengths of exposure light from a mercury lamp light source centering on light having a wavelength of 365 nm; and, consequently, conventional photosensitive resin layers are unable to adequately absorb light having a wavelength of 400-450 nm, and as a result of this are unable to initiate photopolymerization and have a problem of low sensitivity. In particular, photosensitive resin compositions previously utilized have low sensitivity and inadequate resolution to light having a wavelength of 400-450 nm. Note, in particular, paragraph [0007] bridging pages 2 and 3 of Applicants' specification.

While the blended amount of photopolymerization initiator can be increased to achieve higher sensitivity, starting from conventional photosensitive resin compositions, the cross-sectional shape of the formed resist ends up being that of an inverted trapezoid, resulting in the problem of occurrence of a discrepancy between the wiring pattern subsequently formed by etching treatment or plating treatment and the pattern that is exposed. In particular, the width of the resist pattern becomes smaller moving from the surface of the resist towards the substrate interface, causing the aforementioned discrepancy.

Against this background, Applicants provide a photosensitive element using a specified photosensitive resin composition, the element having superior sensitivity and resolution with respect to exposure by light having a wavelength of 400-450 nm; that is, the photosensitive element has the property of photosensitivity to light at a wavelength in a range of 400-415 nm. Applicants have found that by incorporating, in the photosensitive resin composition forming the photosensitive resin composition layer of the photosensitive element, both a thioxanthone-based compound represented by the chemical formula (I) in claim 1 and also an acylphosphine oxide compound represented by the chemical formula (II) in claim 1, the element having photosensitivity to light with wavelength in the recited range, various objectives of the present invention are achieved.

In addition, by including styrene or a styrene derivative as a polymerizable monomer for the (A) binder polymer, such styrene or styrene derivative being included in an amount as in claim 1, satisfactory adhesion and separation characteristics are

achieved, as described in paragraph [0038] bridging pages 11 and 12 of Applicants' specification.

Sakanashi, et al. discloses a photopolymerizable resin composition containing specific amounts of polymer having a carboxyl group in a side chain and having a weight-average molecular weight of 20,000-500,000; N-phenylglycine and p-aminophenyl ketone or thioxanthone compound as a photopolymerization initiator; and a photopolymerizable polyfunctional unsaturated compound of formula 1 of this reference. Note the English-language abstract of Sakanashi, et al. See also paragraphs [0001], [0005], [0010], and [0015] of the machine-generated English translation of Sakanashi, et al.

It is respectfully submitted that Sakanashi, et al. does not disclose, nor would have suggested, including 3-30% by weight of styrene or styrene derivative as a copolymerizable component, or including an acylphosphine oxide compound, as in claim 1, and advantages thereof.

Moreover, it is respectfully submitted that Sakanashi, et al. is designed to accommodate laser exposure of light having wavelengths of 365±20 nm (that is, i-line light), as described in paragraph [0007] of Sakanashi, et al. It is respectfully submitted that this reference does not disclose, nor would have suggested, such photosensitive element, or use thereof, as in the present claims, including wherein the photosensitive element has the property of photosensitivity to light at a wavelength in a range of 400-415 nm, and advantages due thereto, as discussed in the foregoing.

It is respectfully submitted that the additional teachings of Wolf, et al. would not have rectified the deficiencies of Sakanashi, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Wolf, et al. discloses bathochromic mono- and bis-acylphosphine oxides and sulfides, as well as use of these compounds as photoinitiators. The compounds described in this patent are of formula I, described from column 1, line 26 through column 6, line 40, of this patent. See also the paragraph bridging columns 29 and 30 of this patent, as well as the first full paragraph in column 30 of this patent, disclosing binders added to the compositions described in Wolf, et al.

Initially, note that the acylphosphine oxide compounds in Wolf, et al. include, in addition to the phosphorus-containing group between the aromatic groups, an additional carbonyl group. Even assuming, arguendo, that the teachings of Wolf, et al. were properly combinable with the teachings of Sakanashi, et al., such combined teachings would have neither disclosed nor would have suggested the photosensitive element or use thereof as in the present claims, including both the thioxanthone-based compound represented by the chemical formula (1) and also the acylphosphine oxide compound represented by the chemical formula (II) as in the present claims, and advantages thereof.

In addition, it is respectfully submitted that the combined teachings of Sakanashi, et al. and of Wolf, et al. would have neither taught nor would have suggested such photosensitive element, and use thereof, as in the present claims, including the photosensitive resin composition that contains a binder polymer which contains 3-30% by weight, relative to all copolymerizable components, of styrene or a styrene derivative

(more specifically, styrene as in claim 22) as a copolymerizable component, and advantages thereof; and/or wherein the photosensitive element has a property of photosensitivity to light at a wavelength in a range of 400-415 nm, as in all of the present claims, and advantages thereof; and/or other features of the present invention as discussed previously, and advantages due thereto.

The contention by the Examiner in the third paragraph of Item 3, on page 3 of the Office Action mailed December 11, 2008, that Wolf, et al. discloses acylphosphine oxides and their use as photoinitiators, and that compounds disclosed by this reference "meet the instant structural limitations of the instant claims 6 and 7", the Examiner pointing to column 37 and Examples of Wolf, et al., is noted. Column 37 of U.S. Patent No. 7,148,382 discloses compositions wherein additional photoinitiators (c) are compounds of formulas (III)-(VI). Only formula (V) includes phosphorus, but the compound of formula (V) includes a carbonyl group, in addition to the phosphorus-containing group, between R_{41} and R_{42}. Attention is also directed to the Examples in Wolf, et al., beginning at column 51 thereof. It is respectfully submitted that the Examiner has not established obviousness of compositions including, inter alia, the acylphosphine oxide compound represented by the chemical formula (II), especially together with the thioxanthone-based compound represented by the chemical formula (I), as in the present claims, with advantages due thereto as discussed in the foregoing; and, moreover, also including the binder polymer which contains specified amounts of styrene or a styrene derivative, as in the present claims, and advantages due thereto.

Furthermore, it is respectfully submitted that the combined teachings of Sakanashi, et al. and of Wolf, et al. do not disclose, nor would have suggested, a photosensitive element having a property of photosensitivity to light at a wavelength in a range of 400-415 nm, as in the present claims, and advantages due thereto.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently pending in the above-identified application are respectfully requested.

Applicants request any shortage of fees due in connection with the filing of this paper be charged to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case 1303.46057X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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